Appendix – Project Implementation Plan (PIP)

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1.0 INTRODUCTION

The overall success of any watershed initiative to address water quality concerns is a result of a strong locally led watershed committee. The Upper Weber River Watershed is a prime example of an area with the need for an active and well supported watershed committee to effectively and fairly determine the best course of action to achieve water quality goals. The Division of Water Quality has direct regulatory authority over point sources in the watershed, but does not exercise a similar authority in regards to non-point sources of pollution. As a result, the potential exists for point sources to bear an undue share of the reductions needed to meet TMDL requirements.

Accordingly it is recommended that the following stakeholders take an active role participating in and supporting the Upper Weber River Watershed Committee in order to assure a fair and reasonable approach is taken to achieve the goals of this TMDL:

- Summit County Commission
- Summit County Soil Conservation District
- Kamas Valley Soil Conservation District
- Weber River Water Users
- Weber River Water Conservancy District
- Coalville City
- Oakley City
- Kamas City
- Snyderville Basin Water Reclamation District

The allocations proposed in this TMDL can be achieved through a variety of point and non-point source reductions. This TMDL report has proposed one possible allocation to achieve needed reductions but there are other solutions and allocation scenarios that may work as well or better if orchestrated through an active watershed committee. The Upper Weber River Watershed Committee must take a lead role in overseeing the implementation of this TMDL and determining fair, economically feasible solutions to achieve the goals of this TMDL. This should include an aggressive pursuit of funding for non-point source projects as well as a major role in facilitating any pollutant trading between point sources and/or non-point sources.

In order to achieve water quality targets and TMDL endpoints, it will be necessary to implement practices that are commonly described as Best Available Technologies (BATs) or Best Management Practices (BMPs). BATs are used to treat effluent discharged by any type of facility through a distinct location such as a culvert or ditch. Effluent limits associated with BATs are typically based on the average performance of the best technology that can be used to treat parameters of concern. BMPs are practices used to protect the physical and biological integrity of surface and groundwater, primarily with regard to non-point sources of pollution. BMPs are most effective when combined to create a BMP system that will comprehensively reduce or eliminate pollution from a source. It should be noted that no single BMP system is considered to be the most effective way of controlling a particular pollutant in all situations. Rather, the design of a BMP system should consider local conditions that are known to influence the production and delivery of non-point source pollutants. The design of a BMP system should not only account for the type and source of pollutant, but should also consider background factors such as the physical, climatic, biological, social, and economic setting. Since a significant proportion of the load reductions required to meet this TMDL originate from non-point sources a rigorous monitoring program will be required through the period of implementation to provide reasonable assurance that the BMPs are effective. The Utah Division of Water Quality has and will continue to monitor the chemical, physical and biological parameters of water quality within the Echo Reservoir Watershed.

Echo Reservoir is currently impaired for low levels of DO (Figure 1). This TMDL has determined that the existing annual total phosphorus loads of 24,350 kg/yr to Echo Reservoir be reduced by approximately 19 percent in order to meet the TMDL Target Load of 19,800 kg/yr. It is anticipated that if the target load is met, DO concentrations will fully support the beneficial use for cold water aquatic species associated with Echo Reservoir.

Figure 1. Echo Reservoir.

As pollutant loads are transferred through the TMDL study area, they are influenced by a number of different processes that reduce the mass of total phosphorus delivered to a subwatershed or watershed outlet and ultimately to Echo Reservoir. Some of these processes can include adsorption, algal uptake, settling, and flow diversion for irrigation purposes. A linkage assessment defining the relationship between watershed loads and watershed outlet loads has been previously defined in Chapter 4. The BATs and BMPs recommended in this report will address watershed loads of total phosphorus before they enter a receiving water body (total watershed loads). If BATs and BMPs are applied as recommended in this document, it is anticipated that watershed outlet loads will meet the TMDL Target load of 19,800 kg/yr. Existing and future watershed outlet loads are shown in Table 1. The recommended pollutant load allocation for total watershed loads is provided below in Table 2.

A total of seven pollutant sources have been identified during the assessment of water quality conditions in the TMDL study area including the following:

- Point Sources
- Animal feeding operations (AFOs)
- Land areas receiving manure applications
- Private land grazing
- Public land grazing
- Septic tanks
- Diffuse runoff

The TMDL has allocated total phosphorus loads to each pollutant source. The target load associated with the TMDL does not require load reductions from all pollutant sources. However, all sources listed above are considered significant in terms of their influence on water quality conditions in Echo Reservoir. As such, reasonable effort should continue to be made to minimize the influence of each source as development and growth occurs in the watershed areas above Echo Reservoir.

The remainder of this appendix will include recommendations for achieving the necessary reductions from each source and the cost associated with these activities.

Table 1. Existing and future watershed outlet loads by source.		
	Existing Outlet Load (kg/yr)	**Future Outlet Load (kg/yr)**
Point Sources		
Coalville WWTP	149	446
Silver Creek WRF	2,157	8,111
Oakley WWTP	138	475
Kamas WWTP	385	1,043
Kamas FH	126	195
Total Point Source Load	**2,955**	**10,270**
Non-point Sources		
Chalk Creek		
AFOs	231	228
Land applied manure	897	885
Public land grazing	0	0
Private land grazing	3,296	3,281
Septic Systems	22	38
Diffuse Runoff	6,098	6,339
Weber River below Wanship		
AFOs	35	32
Land applied manure	499	459
Public land grazing	0	0
Private land grazing	821	788
Septic Systems	72	197
Diffuse Runoff	2,911	3,328
Weber River above Wanship		
AFOs	343	320
Land applied manure	1,035	965
Public land grazing	57	57
Private land grazing	1,081	1,059
Septic Systems	64	198
Diffuse Runoff	3,931	4,043
Total Non-point Source Load	**21,393**	**22,217**
Grand Total	**24,348**	**32,488**

Table 2. Allocation of total watershed loads by pollutant source[a].				
	Existing Watershed Load (kg/yr)	**Future Watershed Load (kg/yr)**	**Load Allocation (kg/yr)**	**Percent Reduction (%)**
Point Sources				
Coalville WWTP	149	446	823	0
Silver Creek WRF	4,070	15,305	5,733	63
Oakley WWTP	475	1,631	798	51
Kamas WWTP	1,322	3,583	1,656	50
Kamas FH	434	675	805	0
Total Point Source Load	**6,450**	**21,640**	**9,815**	**55**
Non-point sources				
Chalk Creek				
AFOs	248	245	24	90
Land applied manure	961	949	190	80
Public land grazing	0	0	0	0
Private land grazing	3,535	3,518	2,463	30
Septic Systems	24	41	41	0
Diffuse Runoff	6,539	6,798	5,215	23
Weber River below Wanship				
AFOs	66	61	6	90
Land applied manure	942	866	173	80
Public land grazing	0	0	0	0
Private land grazing	1,550	1,487	1,041	30
Septic Systems	135	371	371	0
Diffuse Runoff	5,493	6,280	4,710	25
Weber River above Wanship				
AFOs	1,181	1,101	110	90
Land applied manure	3,560	3,318	664	80
Public land grazing	196	196	196	0
Private land grazing	3,718	3,643	2,550	30
Septic Systems	221	680	680	0
Diffuse Runoff	13,517	13,899	10,424	25
Total Non-point Source Load	**41,886**	**43,453**	**28,858**	**34**
Grand Total	**48,336**	**65,093**	**38,673**	**41**

[a] Allocation of total Watershed Loads shown here will meet the TMDL Target Load of 19,800 kg/yr to Echo Reservoir. Conversion of total watershed loads to watershed outlet loads is described in greater detail in Chapter 4.

2.0 POINT SOURCES

Total phosphorus loading from point sources is generated by 5 different facilities in the study area. Four of these operations treat wastewater generated from small towns and nearby residential areas. One facility discharges water from a fish hatchery operated by the Utah Division of Wildlife Resources (UDWR). Source water for the fish hatchery is obtained from two springs located near the facility. A listing of all point sources in the study area is provided below in Table 3 and includes the existing and projected future total phosphorus loads.

Table 3. Annual total phosphorus loads from point sources in the Echo Reservoir watershed.

Point Source Name	Receiving Water	Existing total phosphorus Loads (kg/yr)	Future total phosphorus Loads (kg/yr)	Percent Increase (%)
Coalville Wastewater Treatment Plant	Chalk Creek	149	446	200
Snyderville Basin Silver Creek Water Reclamation Facility	Silver Creek	4,070	15,305	276
Oakley Wastewater Treatment Plant	Weber River	475	1,631	243
Kamas Lagoons	Beaver Creek	1,322	3,583	171
UDWR Kamas Fish Hatchery	Beaver Creek	434	675	56
Total of all Point Sources		**6,450**	**21,640**	**236**

Increased population growth within existing municipal boundaries and other sewered areas will result in increased discharge and loading from the four water treatment facilities. Future loads from each of these facilities were based on the assumption that existing per capita water use will not change. As a result, the assumption was made that increased discharge could be directly correlated with population growth. Future discharge from the Silver Creek Water Reclamation Facility (WRF) was determined from information contained in the Snyderville Growth Management Report and estimates provided by the Snyderville Basin Water Reclamation District (Boyle 2005). Future discharge from the Kamas FH is anticipated to increase by roughly 3 cfs following development of the two springs that provide inflow to the facility (Dewey 2004). Future total phosphorus concentration was held constant for all 5 facilities under the assumption that existing methods to treat discharge would not change. Therefore, flow rates were the only variable that was adjusted in order to calculate future loads from point sources.

The TMDL requires that loading from point sources be reduced by roughly 55 percent in order to meet the Target Load. Recommendations to meet this level of reduction are discussed below.

2.1 RECOMMENDED BATs

At the present time, no phosphorus limits are associated with any point source in the study area. The wasteload allocations recommended by this TMDL are shown in Table 2 above. The allocations shown in Table 2 have considered the existing and future operating conditions of each facility, as well as future expansion and development that is anticipated to occur. As each water treatment facility is expanded or modified to treat increased future flows, the ability to remove total phosphorus should be evaluated as a component of the treatment process.

The treatment method selected to achieve the recommended wasteload allocation will vary depending upon several factors such as the existing concentration, rate of flow, and the presence of constituents in the effluent that can promote or hinder treatment. Phosphorus removal systems can use either biological or chemical treatment or in some cases, a combination of both methods. Land application through a secondary irrigation system is another option depending on volume of effluent and available crop land.

It is not the intent of this assessment to provide a design for wastewater treatment that should be applied at each facility. The method used by each point source to remove total phosphorus from effluent discharge should be based on a detailed site-specific engineering assessment. However, the PIP associated with a TMDL should provide sufficient evidence that indicates wasteload allocations can be met, using proven wastewater treatment methods and available technology.

Figure 2. Silver Creek Water Reclamation Facility.

The Silver Creek WRF (Figure 2) will begin construction and expansion activities in 2007 to accommodate future influent flows from Snyderville Basin. Treatment is scheduled to begin in 2007 with a scheduled completion date of 2013 (Boyle 2005). The anticipated design of this facility will remove total phosphorus and nitrogen through biological treatment of wastewater. The opportunity exists for adding equalization capacity to the plant design which would further increase the ability to remove total phosphorus. One of the major limitations to biological treatment of total phosphorus is the amount of volatile fatty acids available to fully trigger the biological phosphorus removal mechanisms (Bowker and Stensel 1987). However, this limitation can be overcome through limited chemical addition or manipulation of the anaerobic/aerobic zones. Discussion with personnel from the Snyderville Basin Water Reclamation District indicated that the design of the upgraded plant would consistently produce effluent with total phosphorus concentrations less than 1.0 mg/l total phosphorus. Under the projected future flow from the Silver Creek WRF, an effluent stream with concentrations less than 1.0 mg/l total phosphorus would meet the recommended load allocation. It is noted that the design of the wastewater collection system in Snyderville Basin allows influent to be sent to the Silver Creek facility or to a similar facility located in nearby East Canyon Creek. During the upgrade to Silver Creek WRF a greater percentage of influent flows will be transferred to East Canyon. As a result, total phosphorus loads from the Silver Creek WRF during 2007 through 2013 will likely be reduced when compared to previous years.

The Oakley WWTP was upgraded in June 2003 from lagoon treatment to a membrane filtration system capable of phosphorus removal. However, they are not currently treating effluent for removal of phosphorus. Chemical addition to influent (most likely alum) at the Oakley WWTP would initiate phosphorus precipitation and subsequent removal by membrane filtration. It is widely acknowledged that total phosphorus removal through chemical addition can result in total phosphorus concentrations less than 1.0 mg/l (Water Pollution Control Federation 1983). Under the projected future flow from the Oakley WWTP, an effluent stream with concentrations less than 1.0 mg/l total phosphorus would meet the recommended load allocation.

The Coalville WWTP currently operates below design capacity (Table 4). The Coalville WWTP completed improvements to their collection system during 2000 which resulted in significantly reduced flows and total phosphorus concentrations. A recent engineering assessment of the Coalville WWTP has indicated that increased total phosphorus concentration in the effluent stream will likely occur in the near future, due to local development.

Table 4. Existing and projected design characteristics for point sources in the Echo TMDL study area.

Name	Design Capacity (MGD)	Operating Level	Estimated time to design capacity
Coalville WWTP	0.36	65%	15-20 yrs
Silver Creek WRF	2.0	61%	7 yrs
Oakley WWTP	.25	37%	20 yrs
Kamas WWTP	1.7	25%	> 20yrs
Kamas FH	4.52[a]	69%	5-10 yrs

[a] Design capacity for Kamas FH indicates discharge from two source springs providing inflow to the plant. Time to design capacity for Kamas FH indicates the time period when additional development to source springs will increase discharge to a maximum of 10 cfs.

Population projections for Coalville indicate that expansion of the plant will need to occur within the next 20 years. Future plant upgrades or expansion to the Coalville WWTP would need to include the ability to address total phosphorus loading. Small facilities capable of treating 1-2 MGD generally use a combination of biological and chemical treatment to remove phosphorus. Methods such as these can achieve total phosphorus concentrations less than or equal to 1.0 mg/l (Bowker and Stensel 1987) (US-EPA 2000). Total phosphorus concentrations at this level would meet the recommended load allocation for Coalville WWTP under the projected future flows.

The Kamas WWTP uses a lagoon system to treat wastewater and sewage influent from the Kamas area. Although the system is operating well below design capacity, the ability to treat for total phosphorus does not currently exist. Removal of total phosphorus through lagoon systems is typically more difficult in comparison to facilities where wastewater can be treated in a more confined setting such as membrane filtration, oxidation ditch, or ring clarifier systems. Some of the challenges associated with phosphorus removal from lagoon systems include seasonal algal blooms, mixing of surface water and algae (which re-suspends precipitated solids), and management of chemical additions. Typical removal processes can include aeration, slow sand filtration, and chemical addition to lagoon cells or clarifiers that follow the lagoon system. Application of these treatment methods would require additional development to the Kamas lagoon system. Application of the phosphorus removal processes mentioned here is known to result in effluent total phosphorus concentrations of 1 mg/l or less (Pycha and Lopez 2003). Total phosphorus concentrations at this level would meet the recommended load allocations for the Kamas WWTP under the projected future flows.

Existing mean total phosphorus concentrations in the Kamas FH discharge are less than 0.1 mg/l (see Appendix Data). As described in Chapter 5, additional development to the source springs that support this facility are expected to occur within the next 5-10 years, increasing the maximum discharge to 10 cfs or roughly 6.4 MGD. It is not expected that the Kamas FH will change the methods that are currently used to minimize total phosphorus loading. The load allocation shown in Table 2 is based upon the existing monthly distribution of total phosphorus concentration and projected future flows. The intent of this allocation is to accommodate future flows while maintaining or decreasing total phosphorus concentrations. It is recommended that the Kamas FH continue to implement reasonable efforts to minimize total phosphorus concentrations in effluent discharge.

2.2 WATER QUALITY TRADING

Under the traditional paradigm (as detailed above), the point source dischargers within the watershed would in all likelihood eventually need to upgrade their facilities in order to meet future phosphorus load allocations. However, the economics involved with upgrading the smaller WWTP facilities appear to be cost prohibitive, thus making this approach infeasible in addressing phosphorus loading. Given the significantly different costs for each facility to reduce phosphorus, the Echo Reservoir TMDL provides an opportunity to implement a water quality trading approach.

EPA's Water Quality Trading Policy (January 13, 2003) has been developed to "achieve water quality goals more efficiently…Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost." (http//www.epa.gov/owow/watershed/trading.htm)

This approach could lend itself particularly well to the Echo Reservoir watershed because a TMDL has already been developed and the pollutant of concern is total phosphorus. Snyderville Basin Water Reclamation District has completed an assessment of capital costs involved to install chemical phosphorus removal in the Silver Creek WRF. The proposed system could reduce phosphorus to a concentration of 0.4 mg/L or lower. Given the size of the effluent stream processed by the Silver Creek facility, this proposed treatment would be sufficient to address all needed point source reductions for this TMDL. The capital and ongoing operation and maintenance costs for treatment of phosphorus from the Silver Creek facility appear to be many times less than the cost for the smaller municipalities to upgrade their facilities to remove phosphorus. Making use of the economies of scale available at the Silver Creek WRF may be the most cost effective solution to achieve all of the point source allocations proposed in this TMDL.

3.0 ANIMAL FEEDING OPERATIONS/LAND APPLIED MANURE

A total of 18 AFOs are located in the Echo Reservoir TMDL study area (Figure 3) (Loveless 2004). Although scattered throughout the watershed, it is assumed that these operations are generally located in the low-lying agricultural areas within a couple of miles of existing stream courses. Some of the operations in the Echo Reservoir watershed are seasonal in nature, and others have confined animals year round. It is assumed that varying levels of nutrient management practices have been implemented at these operations, although little information is currently available to characterize the AFOs within the watershed.

Loading from AFOs occurs through two different processes. The first process involves direct stream loading caused from runoff generated during storm events or routine cleaning at each operation. Animal wastes are carried by overland flow into adjacent water bodies. The second process involves loading from areas that receive application of animal manures for fertilization during certain times of the year. Animal wastes that are not immediately incorporated into the soil are available to be washed into adjacent streams with runoff generated by precipitation events. A more detailed description of these processes as they occur in the study area is included in Chapter 4 of this report.

Figure 3. Animal feeding operation in the TMDL study area.

The UACD has indicated that 10 of the 18 AFOs have the potential to deliver nutrient loads to the Weber River (Loveless 2004). This TMDL assumes that all 18 operations have the potential to contribute loading to Echo Reservoir through land application of manure to fields that are associated with each operation. In order to meet the TMDL, loading from AFOs must be reduced by 90 percent while loading from land applied manure must be reduced by 80 percent.

3.1 RECOMMENDATIONS

The State of Utah has developed a plan to address loading from AFOs through a combination of voluntary incentive-based programs as well as enforcement of regulatory guidelines on large facilities (Utah AFO\CAFO Committee 2001). It is anticipated this program will play a critical role in implementing nutrient management activities on all 18 operations in order to achieve the desired load allocations recommended by the TMDL.

A variety of activities can be used to minimize or eliminate the potential for nutrient loading from feedlots, barnyards and dairy milk parlors that are associated with AFOs. NRCS agency personnel are currently working with many of the farmers and ranchers in the TMDL study area (Broadbent 2004). Some of the practices used to develop Comprehensive Nutrient Management Plans (CNMPs) are listed below in Table 5 and Table 6. Unit costs associated with each of these practices are also provided.

Table 5. Best management practices recommended for AFOs in the Echo TMDL study area.		
NRCS Conservation Practice ID	**Description**	**Per/Unit cost estimate**
313	Waste Structure (including concrete retaining wall and manure bunker)	\$270 / yd^3
313	Waste Structure (expand existing manure bunker)	\$300/ yd^3
614	Offsite watering system	\$1.50 / gallon
393	Filter Strip	Site prep = \$70/ac - \$100/ac
390	Riparian Herbaceous Cover	Seed or trees = \$50/ac
386	Field Border	Planting = \$20/ac
382	Fence	\$2 / linear foot
313A	Manure Staging Area	\$1,500

Table 6. Best management practices recommended for land areas receiving land application of animal manures.		
NRCS Conservation Practice ID	**Description**	**Estimated cost**
590	Nutrient Management	\$10/ac
370	Conservation Cover	Seedbed preparation, planting, seed = \$105/ac
393	Filter Strip (30 ft wide) where necessary at downslope end of field to prevent overland flow.	Site preparation(light), seedbed preparation, planting, seed = \$250/ac
328	Conservation Crop Rotation	\$11.50/ac
329 and 344	**Residue Management**	
	Fertilizer application based on soil test phosphorus (STP) levels.	\$8.50 / sample$_1$
	Band applications of commercial phosphorus near the seed row.	Non-structural – no cost
	No application of manure within 250-750 ft. of stream channel	Non-structural
	Manure only applied to areas not frozen or absent of snow	Non-structural
	Incorporation of all manure within 24 hours	Non-structural
	Delay application within 24 hours of forecasted storm events.	Non-structural

Most of the practices used to eliminate on-site nutrient loading from feedlots involve creating a structure or staging area to store animal manures on a temporary basis (Table 5). When the structure is full, the manure can be transported to nearby fields and used as fertilizer. Other measures such as filter strips and runoff berms minimize the potential for surface runoff during storm events. The ability of BMPs in Table

5 to remove total phosphorus is generally considered to be 90 percent efficient. A critical measure to reducing pollutant loads from AFOs is to eliminate direct access by animals to surface water located adjacent to or within feedlot boundaries. Managing wastewater from dairy parlor areas can reduce or eliminate surface runoff, thus removing over 90 percent of total phosphorus loading from this source alone (Macgregar et al. 1982) (Zimmerman 1998)(Jamieson et al. 2001). Proper use and maintenance of manure storage bunkers and staging areas can further reduce the potential for runoff contribution from AFOs.

It is recommended that nutrient management in areas where manure is applied use structural and non-structural techniques (Table 6). Structural techniques include construction of filter strips that border fields, conservation covers, and use of crop rotation. These measures will minimize surface runoff and promote infiltration. Non-structural techniques are management oriented.

The BMPs recommended by this TMDL continue to support land application of manure for pasture fertilization. This PIP recommends that the amount, timing, and specific areas where manure is applied follow the strategy typically recommended by the NRCS and detailed in conservation practices included in Table 6. The combined efficiency of BMPs to reduce total phosphorus loading from land applied manure is estimated to be 80 percent. Tabbara (2003) indicates that incorporation of manure into the soil immediately following application will reduce total phosphorus availability by 50 percent. A summary of buffer strip efficiencies by Allaway (2003) indicated removal of total phosphorus ranging from 67 percent to 74 percent. Width of buffer strips has been shown to be one of the most significant factors in removing total phosphorus from runoff (Barfield et al. 1998; Schmitt et al. 1999; Lee et al. 2000). Application of manure based on soil test measurements of phosphorus will reduce the potential for over-application of manure. It is not known at this time how much of a reduction will occur if manure application is based on agronomic rates (i.e. application is equivalent to plant uptake). No information is available on existing manure application rates in the TMDL study area. Eliminating manure application on frozen soils or in areas near streams would also reduce the potential for nutrient contributions to surface runoff. Although it is known that these conditions occur in the TMDL study area, no information is available to quantify existing loads from manure applications to these areas.

It is anticipated that if each of the 10 AFOs implement and maintain nutrient management plans according to NRCS guidelines, the TMDL allocation for this source will be met. In order to achieve the TMDL allocation for land areas receiving applied manure, all 18 facilities would be required to comply with the techniques listed in Table 6. This is a conservative assumption as some AFOs may be in watershed areas with little or no potential to contribute loads from land applied manure. Due to the lack of site specific information, this assumption will be used to ensure the allocation is met.

4.0 GRAZING

Grazing livestock are present throughout many of the low-lying, privately owned areas in the watershed (Figure 4). In addition, all or portions of five USFS grazing allotments are present in the watershed, mainly in the upper Weber River and Beaver Creek drainages. The following discussion will address BMPs needed to reduce loading contributed to streams in the TMDL study area from grazing on private lands within the watershed. Although pollutant loads have been calculated for grazing on public lands, no BMPs are recommended at this time as they are already subject to Federal Grazing Standards and Guidelines.

In general, the primary mechanisms by which loading from grazing animals occurs includes direct deposition of manure to existing water bodies and surface runoff from areas where livestock have grazed. During field visits to the TMDL study area, animals were observed grazing throughout the watershed on private lands. Efforts were made to manually count these animals where they were observed, and the locations along with the number and type of animals were recorded. However, field personnel were limited to public transportation routes. As a result, animal counts may not be inclusive of all animals grazing on private lands in the watershed. Conservative assumptions and a margin of safety included in the TMDL account for this uncertainty.

Figure 4. Livestock grazing on privately owned land in TMDL study area.

No information was available to determine the period of time when animals were grazing on private land areas or the frequency with which livestock herds visit certain areas. Large tracts of land are found in the upper portions of the Chalk Creek watershed that extend to the Utah – Wyoming border. It is known that livestock herds pass through these areas during the summer months. In contrast livestock herds observed on valley bottoms consistently graze these pastures in a rest-rotation pattern during the summer. It is likely that some herds winter over in these areas due to access for feeding purposes.

The TMDL recommends that loads from private land grazing be reduced by roughly 10 percent under existing conditions and 30 percent by the year 2025.

4.1 RECOMMENDATIONS

A list of appropriate BMPs for reducing loads from grazing on private lands are included below in Table 7. Many privately owned pastures are located between Echo Reservoir and Wanship Reservoir, Kamas Valley, and the lower Chalk Creek watershed area. Observations made during summer 2004 indicated a high level of direct access to water by livestock in the lower Chalk Creek area and throughout the Kamas valley. A total of 914 Animal Units (AU) with direct access to water were estimated to produce a total watershed load of 4,494 kg/yr. In comparison, a load of 4,308 kg/yr total phosphorus was attributed to 2,187 AUs located within 100 meters of the receiving waters.

Table 7. Recommended BMPs for reducing loads from grazing on private lands.		
NRCS ID (where applicable)	**Description**	**Cost**
382	Fence	$2 / linear foot
614	Offsite watering system	$1.50 / gallon
393	Filter Strip	$250/acre
	Maintain a minimum herbage stubble height of 4-6 inches within riparian areas. Allow adequate time for re-growth of plants in these areas before reuse.	Non-structural
	Limit springtime grazing of herbaceous vegetation to not exceed 65 percent. Limit livestock use from riparian areas when primary forage plants are still in the vegetative state (early growth stage).	Non-structural
	Rest-Rotation grazing. Allow adequate rest for vegetation recovery in pastures and allotments. Consider limiting grazing in pastures containing riparian areas during hot periods when livestock use of riparian areas typically increases.	Non-structural
	Ensure all livestock are removed from each pasture at the end of the specified use period. Recovery of riparian areas is reduced if some animals remain following use period.	Non-structural
	Implement streambank disturbance standards that require a percentage of stream channels to be in a stable condition before grazing is allowed within pastures adjacent to water.	Non-structural
	Implement structural controls where appropriate such as riparian exclosures, fencing of sensitive areas or offsite watering.	Non-structural
	Manage winter feeding to avoid pastures that contribute direct snowmelt runoff to streams.	Non-structural

The amount of total phosphorus that can be controlled by restricting livestock access to streams has been reported at widely different levels. Sheffield et al. (1997) and Line et al. (2000) indicated measured losses in total phosphorus loading of 98 percent and 75 percent, respectively, when livestock were excluded from streams. In contrast, Gary et al. (1983) and Allaway (2003) indicated total phosphorus loading from direct contribution of animal manure of 5 percent and 2 percent, respectively. Line et al. (2000) indicated that some of the reduction in total phosphorus loading was likely due to reduced erosion from channel banks and upslope areas as well as filtering of surface runoff by vegetation. Similar conclusions were reached by Sheffield et al (1997) and Owens et al. (1996) who observed reductions in sediment loss of 70 percent and 40 percent, respectively, following livestock exclusion from channel corridors. It is recommended that buffer strips be used in combination with control of livestock access in the Echo Reservoir TMDL study area. This combination of practices will maximize the efficiency of total phosphorus removal from surface runoff in a given area. The width of buffer strips to be used at a particular location would be determined by field slope and length, density and height of vegetation, and typical runoff volumes. The combined efficiency of BMPs to reduce total phosphorus loading from grazing on private lands is estimated to be 60 percent.

Removing direct access to water should be a first priority to reduce loads from grazing livestock. If all animal units shown in group 1 of Table 4.14 were shifted to group 2 (i.e. remove direct access to water by livestock), total loading from this source would be roughly 6,100 kg/yr for a reduction of over 2,600 kg/yr total phosphorus. This would allow the TMDL load allocation to be met. However, it is unlikely that livestock access to water would be removed for all streams. Additional progress toward the TMDL allocation could be made by managing animal herds located within 100 meters of streams. This would lower the intensity with which animal manure is deposited in areas that contribute runoff during snowmelt and storm events. Further reductions could be obtained through the use of filter strips and growth of riparian areas.

5.0 DIFFUSE RUNOFF

Loads from diffuse runoff are related to land use and specific sources within this category include runoff from agricultural lands, urban/residential areas, rangeland, forest land, and other land cover types. Sediment related phosphorus loading from erosion processes accelerated by grazing and other agricultural practices are also included in this category. It is important to note that while these loads may be related to grazing activities, phosphorus loads associated with animal manure deposited by grazing animals are accounted for separately.

The TMDL requires that loads from diffuse runoff be reduced by roughly 10-14 percent under existing conditions and 23-25 percent by the year 2025.

5.1 RECOMMENDATIONS

Total phosphorus loads contributed from diffuse runoff can be reduced as runoff passes through and across surface vegetation. The amount of total phosphorus removed by vegetation is dependent upon the density of vegetation, time of travel, infiltration capacity, and size of soil particles transported by runoff (Allaway 2003). Land cover in the TMDL study area is generally composed of forest and rangeland vegetation in the upper mountain regions while valley bottoms are covered by pastures and cultivated crops interspersed with urban development (Figure 5).

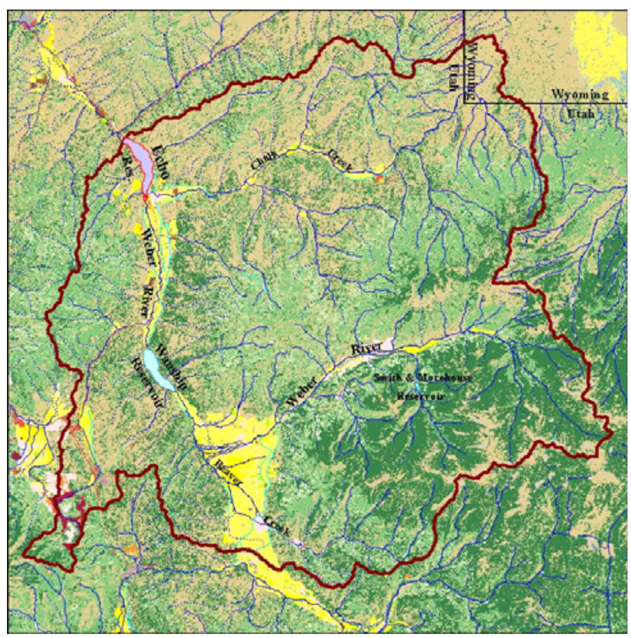

Figure 5. Land use cover used to determine diffuse loads from runoff in the TMDL study.

The effectiveness of the type of vegetation to include in buffer strips has been reported with varying results. Lee et al. (2000) reported that buffers consisting of forbs and large woody plants trapped 21 percent more total phosphorus than did buffers comprised of grass species alone. It was assumed that the woody plant species provided a greater infiltration capacity due to their comparatively deep root structure. The larger biomass of woody species in comparison to grass covers was also anticipated to maintain a greater capacity for total uptake of total phosphorus. In contrast, Schmitt et al. (1999) found few differences between grass and woody species buffer strips.

It is very difficult to make a meaningful comparison between these two types of buffer strips due to the many factors that influence removal efficiency. Allaway (2003) presented a summary of buffer strip efficiency and found that one of the most significant factors is buffer strip width. His review noted that buffer strips between 18 ft. and 30 ft. trap roughly 67 percent of total phosphorus and buffers greater than 33 ft. or more remove 74 percent total phosphorus, on average, from surface runoff volumes. For the purpose of this TMDL, it is anticipated that a 30 ft. buffer strip comprised of grass and forb species will remove 70 percent of total phosphorus loads from diffuse runoff volumes.

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